

## TAXONOMY OF *SOLIDAGO PETIOLARIS* (ASTEREAE: ASTERACEAE) AND RELATED MEXICAN SPECIES

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### ABSTRACT

*Solidago petiolaris* Ait., a species of the central and eastern United States and north central México, is considered here to be variable but without formally recognized infraspecific taxa. *Solidago buckleyi* Torr. & A. Gray, which has sometimes been considered a synonym of *S. petiolaris*, is provisionally maintained as a distinct species. *Solidago orientalis* comb. nov. of northeastern México is recognized at the specific rank, apparently most closely related to the more western *S. wrightii* A. Gray. These last two, in turn, as well as *S. hintoniorum* Nesom, an endemic of the eastern Sierra Madre of México, are most closely related to *S. petiolaris*. A key distinguishes *S. petiolaris* and the Mexican species centered around it.

KEY WORDS: , Astereae, Asteraceae, México

*Solidago petiolaris* Ait. has been considered to comprise several infraspecific taxa, although there has been no general agreement regarding their status. The species, in turn, is part of a larger group from the United States and Mexico united by the common production of cylindric capitulescences, relatively large heads and ray flowers, glabrous or glabrate achenes, and uninerved, epetiolate to short petiolate leaves that are only slightly reduced in size upwards. The present study first considers the taxonomy of *S. petiolaris* and then the status of the Mexican taxa related to it.

### I. TAXONOMY OF *SOLIDAGO PETIOLARIS*

*Solidago petiolaris* is recognized here as a variable species including as synonyms a number of varieties and species. It is distributed from central Texas to

southeastern Colorado, north to Nebraska, Missouri, and Illinois, and eastward to North Carolina and Florida (Map 1). A series of disjunct populations in the Sierra del Carmen, Sierra de Jardín, and Sierra de la Encantada of northeastern Coahuila, México, are not distinguishable from the closest conspecific populations in Texas.

Among all its closest relatives, *Solidago petiolaris* is distinctive in its lack of persistent basal leaves, the cauline leaves mostly even sized upwards along the stem, and particularly in its glandular phyllaries, which are almost always at least slightly viscid with granular or minutely stipitate glands. Sometimes such glands can be found only along the phyllary margins, but their presence may be taken as evidence of the identity of these plants as *S. petiolaris*. The nomenclature of *S. petiolaris* is presented below with comments following on variability and differing opinions regarding its taxonomic treatment.

*Solidago petiolaris* Ait., *Hort. Kew.* 3:216. 1789. Figs. 2, 7. TYPE: UNITED STATES. Cultivated by P. Miller, Oct-Dec 1758 (BM, not seen).

*Solidago squarrosa* Nutt., *J. Acad. Nat. Sci. Philadelphia* 7:102. 1834.

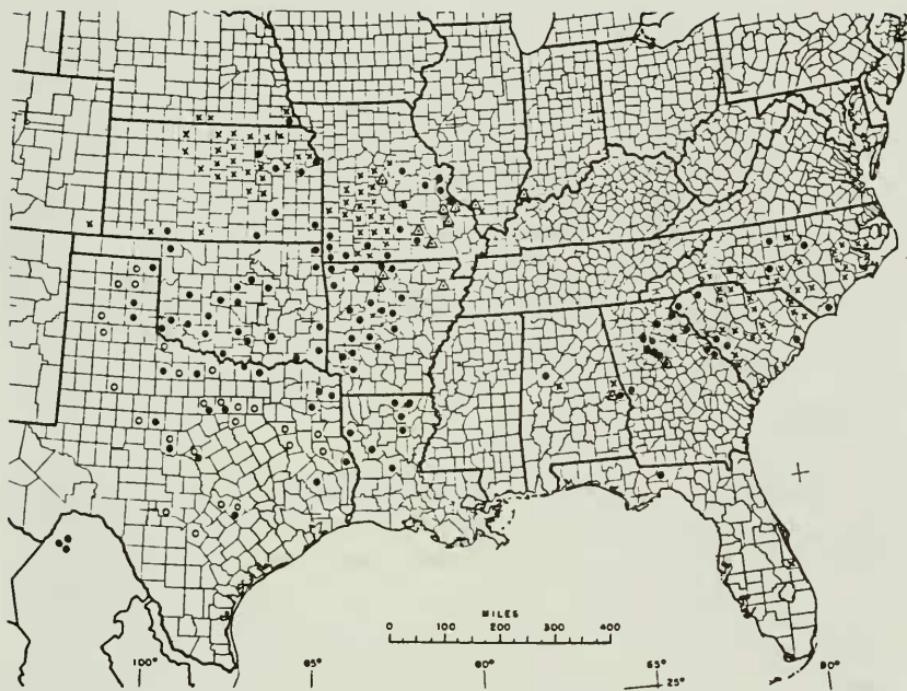
TYPE: UNITED STATES. "Indigenous to the southern section of the union exclusively . . .," no specimen cited (PH); not *S. squarrosa* Muhl. 1813 or Nutt. 1818. *Solidago petiolaris* Ait. var. *squarrulosa* Torr. & A. Gray, *nom. nov.*, *Fl. N. Amer.* 2:203. 1842. *Solidago squarrulosa* (Torr. & Gray) Wood, *Class Book Bot.* (ed. 1861) 431. 1861.

*Solidago angusta* Torr. & A. Gray, *Fl. N. Amer.* 2:204. 1842. LECTOTYPE (designated here): UNITED STATES. Louisiana: [Rapides Parish], Alexandria, [no date,] Dr. Hale s.n. (NY!; Isolectotype: NY!). *Solidago petiolaris* Ait. var. *angusta* (Torr. & A. Gray) A. Gray, *Proc. Amer. Acad. Arts* 17:189. 1882.

Plants of two other collections (NY!) by Hale from Alexandria have broader leaves and were tentatively identified (by Torrey?) as "*S. angusta* var. ?." In the original description, Torrey & Gray also cited a collection by Engelmann made near Hot Springs, Arkansas.

*Solidago lindheimeriana* Scheele, *Linnaea* 21:599. 1848. TYPE: UNITED STATES. Texas: [Bexar or Comal Co.], between New Braunfels and San Antonio, Oct 1848, F.J. Lindheimer 417 (Isotype: GH, according to D. Boufford).

*Solidago wardii* Britt., *Man. Fl. N. States* 935. 1901. TYPE: UNITED STATES. Kansas: Clark Co., 8 mi W of Ashland, 2 Oct 1897, L.F. Ward s.n. (HOLOTYPE: NY!; Isotype: GH according to D. Boufford). *Solidago petiolaris* Ait. var. *wardii* (Britt.) Fern., *Rhodora* 10:87. 1908.



Map 1. Distribution of *Solidago petiolaris* and *S. buckleyi* in the United States and México. Circles mark specimens examined in the present study, while "x's" are records added from literature (GPFA 1977; Radford, *et al.* 1968) to show a more complete distribution for the species. The record for Bibb Co., Alabama is *Kral 41799*, JSU (pers. comm., D. Whetstone); those for Randolph Co., Alabama and Indian River Co., Florida are from Semple, *et al.* 1984; both records for Illinois are added from Mohlenbrock & Voigt (1959). In Texas, plants with prominently hairy leaf surfaces ("var. *petiolaris*") are mapped as hollow circles, those with nearly glabrous surfaces ("var. *angusta*") as solid circles (see text for discussion and further details).

*Solidago milleriana* Mackenzie in Small, *Man. Southeast. Fl.* 1350. 1933. Without citation of specific locality or collection. TYPE?: UNITED STATES. Southeastern USA (not located).

Mackenzie's notation of "[*Solidago petiolaris*]" at the end of the description of *S. milleriana* may have been intended to indicate that the latter was a southern coastal plain segregate of *S. petiolaris*. Alternatively, perhaps it was intended as the basionym of a new name (*nom. nov.*) for an epithet ("petiolaris") thought inappropriate by Mackenzie, the new one recognizing P. Miller, who collected Aiton's type. In any case, there apparently is no specimen among Mackenzie's material at NY that might be taken as a type specimen for this epithet. A single sheet at NY is annotated in script as *S. milleriana* (South Carolina, J.K. Small, et al. s.n.), but the hand does not appear to be Mackenzie's and there is no indication on the sheet that it was considered to be a type.

#### The status of var. *wardii*

In the original description of *Solidago wardii*, Britton distinguished it from *S. petiolaris* by its "silvery" vs. "green" leaves. Fernald (1950), who had earlier reduced this taxon to var. *wardii*, followed with the observation that it differed from *S. petiolaris* "only in the firmer more glutinous and therefore more lustrous foliage." For the most part, the shiny, somewhat "varnished" appearance of the leaves is characteristic of *S. petiolaris* over its whole range, and the surface texture is not correlated with variability in pubescence. I agree with other recent studies in treating *S. wardii* merely as a synonym of *S. petiolaris*.

#### The status of var. *angusta*

Gleason & Cronquist (1963) treated plants with glutinous, glabrous leaf lamina as *Solidago angusta*, regarding typical *S. petiolaris* as a more southwestern species from outside the area of their treatment. Later, Cronquist (1980) recognized var. *petiolaris* and var. *angusta* as "well-marked but wholly intergradient" taxa. Johnston (1970) recognized *S. petiolaris* in Texas with no formal infraspecific taxa, but other recent studies in Louisiana and Texas have recognized the occurrence of both var. *petiolaris* and var. *angusta* (Gandhi & Thomas 1989; Taylor & Taylor 1984; Hatch, et al. 1990). Only var. *angusta* was recognized from the Great Plains (GPFA 1986). The epithet probably was intended by Torrey & Gray to call attention to the narrower leaves, but where var. *angusta* (or *S. angusta*) has been recognized in more recent treatments, it is distinguished from var. *petiolaris* essentially by the following contrasts in vestiture.

1. Leaves scarcely glutinous, not shiny, the lower surfaces densely spreading hairy to softly puberulent; involucres puberulent (often viscidulous) to occasionally glabrous ..... var. *petiolaris*
- 1' Leaves strongly glutinous, shiny, the lower surfaces glabrous or merely scabrous-hispidulous along the midrib and main veins; involucre granular glandular to glabrous ..... var. *angusta*

Although the criteria for identifying these taxa have been relatively consistent, there is no agreement concerning the geographic distribution of the plants concerned. Cronquist (1980) viewed var. *angusta* as "essentially Ozarkian, and south to Louisiana," with var. *petiolaris* more eastern in distribution, and the Great Plains treatment (GPFA 1986) essentially followed this view. In Texas, Taylor & Taylor (1984) found var. *petiolaris* "more common in prairies and short grasslands of western regions," with var. *angusta* in "eastern portions, occasionally in western portions." Gandhi & Thomas (1989) recognized the occurrence of both taxa in north Louisiana.

In the present study, Texas specimens have been mapped (Map 1) in an attempt to sort the plants into two groups corresponding to var. *angusta* and var. *petiolaris* (based on leaf vestiture). The distribution of the putative varieties appears to be patternless, and with the acknowledgment that many of these identifications are more or less arbitrary, it appears that the two putative morphological "nodes" are artificially defined. Further, since many of the "hairy" plants (which would be var. *petiolaris*) of Texas are no less hairy than many from more eastern portions of the range (e.g., in Alabama and Georgia), var. *angusta*, if recognized on this basis, would have to be explicitly acknowledged as largely sympatric with var. *petiolaris*.

There appear to be two geographic segments of *Solidago petiolaris* (Map 1), and in contrast to plants from the western portion of its range, those from Alabama to Florida and North Carolina show a distinct though weak tendency to produce less glandular phyllaries, achenes commonly short strigose near the apex, and leaves slightly hairy on the upper surface. If varieties were recognized, the division would have to be made on this basis, but even these differences are not consistent and there is no geographic pattern of variation in the species over its whole range that would allow the clear recognition of infraspecific taxa.

Diploid plants of *Solidago petiolaris* have been reported from nearly the whole range of the species – in Oklahoma, Kansas, Arkansas, Alabama, South Carolina, and North Carolina (Beaudry 1963, 1969, 1970; Semple, et al. 1984; Semple & Chmielewski 1987). A tetraploid was reported from Indian River Co., Florida (Semple, et al. 1984), apparently far out of the range of the species, and these plants need to be investigated in more detail. Other plants of *S. petiolaris* from Florida appear to be of typical morphology, but most of

the specimens at NY are relatively old collections without precise indications of locality.

#### Species related to *Solidago petiolaris*

*Solidago petiolaris* is closely related to a group of species centered primarily in the eastern United States with cylindric capitulescences and glabrous or very sparsely strigose achenes. Four among these (*S. bicolor* L., *S. hispida* Muhlenb., *S. puberula* Nutt., and *S. roanensis* Porter), as well as several others from México (see below), are similar to *S. petiolaris* in their hairy stems. The remainder are immediately distinguished from *S. petiolaris* in their stems that are glabrous or nearly so below the heads (*S. erecta* Pursh, *S. glomerata* Michx., *S. plumosa* Small, *S. speciosa* Nutt., and *S. squarrosa* Muhlenb.). Yet other species with consistently hairy achenes (e.g., *S. simplex* Kunth) and others with persistent basal leaves and chiefly with strongly interrupted cylindric (axillary) capitulescences are also related, perhaps as closely as those listed above. Achene vestiture is variable even in species that have normally glabrous achenes, and although capitulescences normally are cylindrical in *S. petiolaris* and its relatives noted here, part of the less common variability in these species includes the production of heads in widely interrupted clusters.

#### The identity of *Solidago buckleyi*

*Solidago buckleyi* Torr. & A. Gray, *Fl. N. Amer.* 2:198. 1842. TYPE: UNITED STATES. Alabama: ["interior of Alabama," as cited in the publication], *S.B. Buckley s.n.* (NY-fragments!).

The NY sheet includes three leaves, a short length of stem, and several heads in a small part of the inflorescence. These apparently are fragments of a more complete specimen, which was not located in the present study. Nevertheless, the note below (next paragraph) indicates that the NY specimen may well prove to be the holotype. The date on the packet is "1878," but the specimen probably was collected in 1838 from northern or north central Alabama (*fide* L.J. Dorr, pers. comm.).

A postcard written in 1879 from T.C. Porter to W.B. Canby and attached to a herbarium specimen (Monticello, Georgia, *Porter s.n.*, NY) carries a message regarding the identity of the plant and the type of *Solidago buckleyi*. "The solitary fragment of a specimen (found in the Torrey Herb.) upon which *S. Buckleyi* [exists], came under his [Dr. Gray's] eye, and he declared it positively identical with my plant."

Fernald (1950) treated *Solidago buckleyi* as a species apart from *S. petiolaris* and ascribed to it a range from West Virginia to southern Illinois and Missouri, and south to Alabama. Radford, *et al.* (1968) included *S. buckleyi* within *S. petiolaris* and recognized no varieties within the latter, but *S. buckleyi* has been maintained as a distinct species in other relatively recent floristic treatments (*e.g.*, Gleason & Cronquist 1963; Mohlenbrock 1986). In Missouri, Steyermark (1963) maintained it as "a species doubtfully distinct from *S. petiolaris*," although he provided many map points for each taxon. In the most perceptive observation offered to this point, Cronquist (1980, p. 124) noted that "the name *S. buckleyi* T. & G. has been applied to a heterogenous group of plants from the Ozarkian and southern Appalachian regions" and that its taxonomic position is uncertain. In these previous studies, the two taxa have been separated by the contrasts in the following couplet (for the most part drawn as a composite from several sources).

1. Stems hispid-puberulent with more or less rigid hairs 0.1-0.3(-0.5) mm long, distinctly upturned at the apices; leaves thick, firm to coriaceous, glutinous and appearing varnished shiny, the larger 0.5-3.0 cm wide, uppermost (below inflorescence) 1-6 cm long, the margins entire or occasionally few toothed, scabrous-ciliolate with short incurving hairs; inner phyllaries lance-attenuate; capitulecence elongate, simple and crowded  
..... *S. petiolaris*
- 1' Stems puberulent-pilose with loose hairs 0.3-0.8 mm long, these sometimes apically upturned like *S. petiolaris*; leaves thin, membranous, not glutinous and appearing unvarnished dull, the larger 2.5-5.0 cm wide, uppermost 3-14 cm long, the margins mostly sharply serrate, with long divergent cilia; inner phyllaries oblong, obtuse to acute; capitulecence loose and interrupted, leafy bracted ..... *S. buckleyi*

Among plants examined in the present study, putative differences in stem vesture, phyllary morphology, and capitulecence shape have not proved to be diagnostic or constant, but the two taxa can be distinguished on the basis of leaf morphology, as in the following couplet.

1. Leaves oblanceolate-obovate, often short acuminate at the apex, the mid-cauline 8-14 cm long, 18-40 mm wide at the widest point, margins sharply serrate on at least the upper 2/3 ..... *S. buckleyi*
- 1' Leaves narrowly to broadly elliptic, less commonly slightly oblanceolate, acute at the apex, 3-8(-10) cm long, 8-25 mm wide at the widest point, margins entire to shallowly serrate on the upper 1/2-2/3 .. *S. petiolaris*

The characterizations in the second couplet are drawn from plants of Missouri and Arkansas, where it seems more clear that two distinct entities are

present, based on leaf shape (Figure 1). As in *Solidago petiolaris*, plants identifiable as *S. buckleyi* are separated in geography into an "Appalachian" and "Ozarkian" element (Map 1). The relatively few collections identifiable as *S. buckleyi* from the southeastern United States, however, are not consistently distinguished from *S. petiolaris*, and intermediates are about as common as those identified as the former. A significant example of this can be seen in a set of collections (NY) from the area of Auburn (Lee Co.), Alabama. There, the leaves of the "*S. buckleyi*-like" plants are more similar in shape to those of *S. petiolaris* in the same area than to *S. buckleyi* in the Ozarkian region (Figure 2).

In the Ozarkian region, *Solidago buckleyi* occurs in the northeastern quarter of the range of *S. petiolaris*, and the two taxa appear to be broadly sympatric (Map 1). The distribution map provided by Steyermark (1963) gives additional records for *S. buckleyi* in Missouri, slightly expanding the range shown in the present paper. Both taxa are reported to occur sympatrically in southwestern Illinois (Mohlenbrock & Voigt 1959). The rare plants identified as *S. buckleyi* from Illinois and Indiana are taller than those to the west and mostly have purple, less hairy stems, larger leaves, and less glandular phyllaries, features suggesting that they may be infused with genes from some other closely related species, perhaps *S. speciosa*. Deam (1940) noted that *S. buckleyi* occurs in West Virginia, but no specimens have been seen from there in the present study.

Plants of Ozarkian *Solidago buckleyi* are more similar in their prominently glandular phyllaries to those of *S. petiolaris* from the Ozarkian region than from the Appalachian, and it seems likely that the two geographic segments referred to *S. buckleyi* have been independently derived. In order to test this hypothesis, field studies and analyses of populational variation will be necessary. Although the present research does not provide a resolution to the difficulty in distinguishing *S. buckleyi* and *S. petiolaris*, at least the problem is brought into sharper focus. The Ozarkian populations identified as *S. buckleyi* may prove to be unnamed.

## II. A NEW SPECIES FROM MÉXICO RELATED TO *SOLIDAGO PETIOLARIS*

In an earlier paper (Nesom 1989) I described a new taxon from the mountains of northeastern México, *Solidago wrightii* A. Gray var. *orientalis* Nesom. *Solidago wrightii* is a species of the southwestern United States (Arizona, New Mexico, and Texas) and the western Sierra Madre of México (Chihuahua and Durango), and var. *orientalis* was considered to be the sole representative of

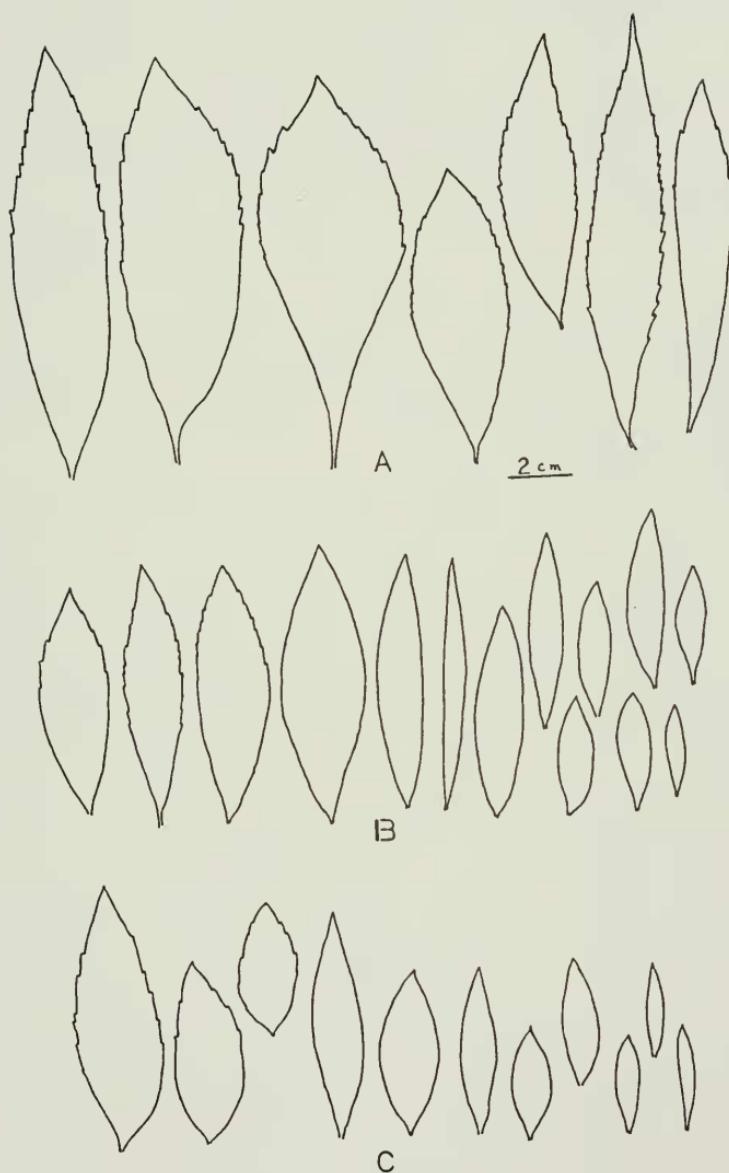


Figure 1. Variation in leaf shape in *Solidago petiolaris* and *S. buckleyi*. A. *S. buckleyi* in Missouri and Arkansas. B. *S. petiolaris* in Missouri and Arkansas. C. *S. petiolaris* in Texas.

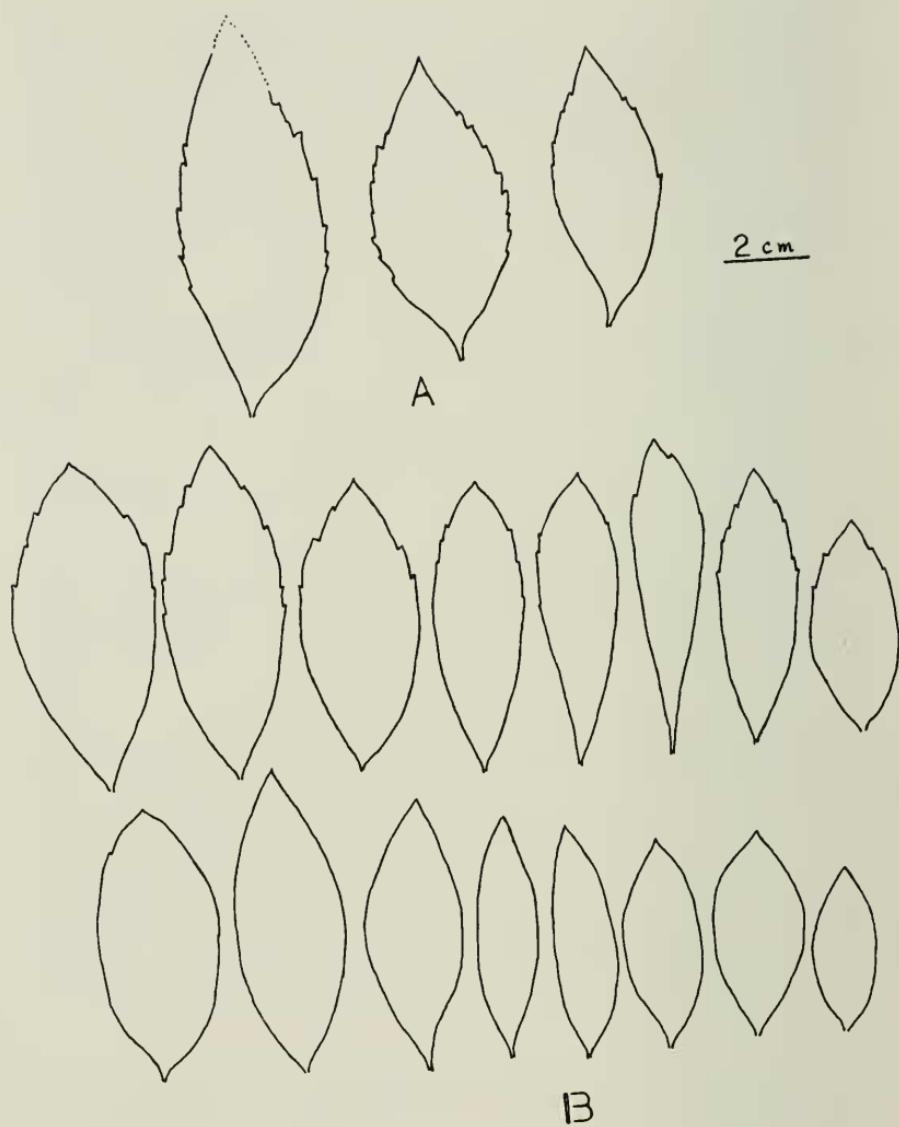


Figure 2. Variation in leaf shape in *Solidago petiolaris* and *S. buckleyi*. A. Three leaves from the type of *S. buckleyi*, collected in Alabama (NY). B. *S. petiolaris* in North Carolina, South Carolina, Georgia, and Alabama.

the species east of its primary range. While var. *orientalis* remains a real entity, evidence from additional collections and insights from further perspective support its recognition at the rank of species.

***Solidago orientalis* (Nesom, comb. et stat. nov. BASIONYM: *Solidago wrightii* A. Gray var. *orientalis* Nesom, Phytologia 67:147. 1989. TYPE: MÉXICO. Coahuila: Mpio. Arteaga, Sierra La Marta, pine and spruce woods, 3100 m, 6 Sep 1981, Hinton, et al. 18333 (HOLOTYPE: TEX!; Isotypes: MEXU!, NY!).**

Additional collections examined: MÉXICO. Coahuila: Mpio. Arteaga, Sierra La Marta, [probable topotype], E end of range, N slope, in fire-disturbed *Pinus-Pseudotsuga* forest, edge of logging road, ca. 3100 m, 24 Aug 1989, McDonald & Mayfield 2560 (MEXU, NY, TEX). Nuevo León: Mpio. Galeana, Cerro Potosí, 1600 m, 22 Sep 1959, Fuentes C. s.n. (TEX); Mpio. Galeana, above El Carrizo, oak woods, 1900 m, 16 Oct 1983, Hinton, et al. 18613 (TEX); Cerro El Gallo, 2000 m, oak and madroño woods, 23 Oct 1988, Hinton, et al. 19257 (TEX).

*Solidago orientalis* was initially hypothesized to be conspecific with *S. wrightii* because of its large, stipitate glands, strigose achenes, and tendency to produce heads in corymbs. Further collections of this taxon, however, consistently show the heads to be cylindrically arranged (with a tendency toward apical broadening). The development of such glandularity, otherwise unknown among their relatives, still appears to be a specialization supporting the treatment of *S. wrightii* and *S. orientalis* as sister taxa. On the other hand, to regard them as conspecific renders the morphological and geographic distinction tenuous between *S. wrightii* and *S. petiolaris*, which are allopatric and separated by consistent differences in vestiture and shape of the capitulecence. The eastern geographic range and cylindric capitulescences of *S. orientalis* are more similar to *S. petiolaris*, and if the latter and *S. wrightii* are treated as separate species, *S. orientalis* is also best regarded at the same rank. *Solidago orientalis* is allopatric with *S. petiolaris*.

That *Solidago wrightii* and *S. petiolaris* are themselves very similar is emphasized by observations that plants of *S. petiolaris* rarely produce an apically broadened capitulecence, approaching a corymboid shape (first noted by Johnston 1970), and that plants of *S. wrightii* from trans-Pecos Texas may produce nearly glabrous achenes. Further, both species, as well as *S. orientalis*, have glands at least on the phyllaries, stems with upturned hairs (when eglandular hairs are present), relatively large heads with prominent ray flowers, and uninerved cauline leaves more or less epetiolate and mostly even sized along on the stem. Although *S. wrightii* is unusual in the corymboid arrangement of heads, it is clearly more closely related to *S. orientalis* and *S. petiolaris* than to any species of the western United States.

*Solidago hintoniorum* Nesom, which is partially sympatric with *S. orientalis* and very similar to it in habit, is also closely related to *S. petiolaris* but distinctive in its complete lack of glands and its sparse, loosely villous vesture. The following key updates one presented in an earlier discussion of *S. petiolaris* and Mexican relatives (Nesom 1989).

#### KEY TO THE MEXICAN SPECIES OF THE SOLIDAGO PETIOLARIS GROUP

1. Capitulescence a terminal corymb usually as wide as long or an open paniculate cluster of similar corymbs; leaves mostly entire; achenes consistently strigose ..... *S. wrightii*
- 1' Capitulescence cylindric; leaves prominently toothed to subentire or entire; achenes sparsely strigose or glabrous ..... (2)
2. Plants completely eglandular; stems sparsely villous with loose, spreading hairs 0.5-1.0 mm long; phyllaries (1-)3(-5) veined; leaves toothed; achenes strigose ..... *S. hintoniorum*
- 2' At least the phyllaries viscid with stipitate to minutely granular glands, the upper stems and leaves glandular or densely puberulent with upcurved hairs mostly less than 0.1 mm long; phyllaries 1(-3) veined; leaves toothed to entire; achenes strigose or glabrous ..... (3)
3. Upper stems densely stipitate glandular, sometimes with a mixture of dense glands and sparse, erect, nonglandular hairs, the upper leaves and phyllaries usually minutely glandular as well; leaves prominently toothed; achenes usually sparsely strigose, sometimes glabrous ..... *S. orientalis*
- 3' Upper stems densely short puberulent and eglandular, less commonly minutely glandular immediately beneath the heads, the leaves eglandular but the phyllaries minutely granular or stipitate glandular; leaves entire to toothed; achenes glabrous or less commonly sparsely strigose ..... *S. petiolaris*